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Evaluation of Mining Polluted Areas Using Multivariate Statistical Approaches: The Case of Gold Mines in the South of Spain

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The Rodalquilar gold mining district (Almería, south Spain) is now an abandoned mining area in which different types of metallic mineralizations appear related with volcanic rocks, usually in the form of sulphides or native elements. As consequence of the extraction of metals (gold, lead, zinc, copper, etc.), important volume of dumps waste are generated, which in contact with air and rainwater could cause acid drainage.

In this work, the effect of the mining activity on waters was monitored determining the content of eleven elements (Mn, Ba, Co, Cu, Zn, As, Cd, Sb, Hg, Au and Pb). A data matrix constructed with the water samples recollected in Rodalquilar mining district has been subjected to different Pattern Recognition techniques such as Hieralchical Cluster Analysis (HCA), Principal Component Analysis (PCA), Factor Analysis (FA) and Linear Discriminant Analysis (LDA) in order to identify different sources of environmental pollution caused by the abandoned mining industry. The Box-Cox transformation has been used to transform the data set in normal form in order to minimize the non-normal distribution of the geochemical data. Unsupervised pattern recognition methods, as HCA, grouped samples into four clusters. PCA and FA confirm this fact, particularly, FA has been allowed to identify different sources of environmental pollution caused by the abandoned mining industry. It can be concluded that the environmental impact is affected mainly by the mining activity developed in the zone (related with the levels of Cd, Zn, Cu, Pb, Co and As found in the analysed waters), the acid drainage (related with the levels of Ba, As, Co, and Mn in waters) and finally, by the chemical treatment (related mainly with the levels of Hg and Au found) used for the benefit of gold (typically amalgamation with mercury or cyanidation). At last, the use of LDA as a supervised pattern recognition method has permit to obtain a discriminant function which generates "grouping scores" from those it is possible to confirm the natural grouping obtained previously.